REMARKS

Claims 1-5 and 8-30 remain in the application.

The Examiner objects to the drawings. Formal drawings submitted at this time should overcome the stated objections.

The Examiner rejects Claims 1 and 3-7 under 35 U.S.C. §103(a) as being obvious over Labeye. The rejection as it applied to Claim 7 is traversed. The restrictions of Claim 7 have been incorporated into base Claim 1. Although such a limitation seems inherent in the recitation of canceled Claim 7, Claim 1 has been further amended to require that the optical elements are individually adjustable, as supported in the filed text at page 2, ll. 10 and 17-19, page 3, ll. 11, 12 and page 6, ll. 1-6 and 23-25.

Lebeye is primarily concerned about a single optical device having a single set of actuators. His multiple mirrors 64, 66 in FIG. 7 and 72, 74 in FIG. 8 are not relevant since they are not individually adjustable and in fact form a single optical element for one beam. However, his embodiments of FIGS. 5 and 6 do show two lenses 65 or 75 having separate sets of electrostatic electrodes. Even so, Lebeye does not suggest adjusting them individually. Instead, at col. 6, ll. he teaches that "in order to obtain the same relative displacement between the two lenses, each lens may be displaced half the distance in opposite directions." At col. 6, ll. 62-65 he further describes the "device with two interlocking movable lenses." Although Lebeye's structure might be capable of individual adjustment, such is not suggested by Lebeye. It is not even clear that individual adjustment would produce a useful result for the optics of Lebeye. Furthermore, Lebeye does not show a 2-dimensional array of individually adjustable optical elements. There is no suggestion to extend the 1-dimensional, 2-element array of FIGS. 5 and 6 in the second dimension to satisfy the two-dimensional requirement of Claim 1. The Examiner asserts only that such an extension would be obvious "to allow for better concentration or packaging issues." Such conclusory advantages are not supported in the applied art and are clearly arrived in hindsight. Lebeye discloses only a single operational optical device. The discussion of fabrication at col. 8, ll. 30-65 and especially ll. 62-65 is directed only to a single

device. The ordinary mechanic reading Lebeye would not be prompted to consider extending his array in a second dimension.

A new dependent claim has been added to require that the deformable element tilt about axes parallel to the principal surface. In contrast, Lebeye's tilting, insofar as it is tilting, is about an axis perpendicular to the principal surface. A similar new dependent claim requires rotation out of the plane of the principal surface. A further new dependent claim includes the restrictions of Claim 8 but depends from amended Claim 1.

A new dependent claim has been added reciting a two-dimensional array of fibers associated with each of the optical elements. Both of the applied references are concerned only with at most one-dimensional array of light beams, and it is not seen how they can be extended to a two-dimensional array of light beams.

The Examiner has rejected Claims 8-11 and 13-19 under 35 U.S.C. §103(a) as being obvious over Labeye in view of WPO Patent No. WO 00/79311 to Abushagur. This rejection is traversed.

In regards to Claim 8, now rewritten in independent form, it is not seen how either Labeye or Abushagur suggests bonding together two substrates each containing a plurality of optical switching devices. Labeye discloses is an optical switching device propagating light in the plane of a single substrate. Abushagur discloses either (1) a plurality of optical switching devices formed in a single substrate and propagating light in a direction parallel to the plane of the substrate (2) a plurality of bases each including a single optical switching device and movable along the plane of the common substrate. Neither Labeye nor Abushagur discloses or suggest forming multiple optical devices in each of two substrates that can thereafter be bonded together. Contrary to the Examiner's statement, it is not obvious "to bond two opposing substrates with the optical devices described by Labeye to achieve a selective switching system as described by Abshagur. Bonding either Labeye's or Abshagur's substrates together in opposition would create switching devices propagating light in non-incident planes. That is, the light from one substrate cannot reach the second substrate.

A dependent claim has been added requiring the bonding to be along the two respective principal surfaces.

In regards to Claim 10, again there is no suggestion in either Lebeye or Abshagur to use to substrates to fabricate respective pluralities of optical devices.

Claim 11 has been amended to again require the bonding along the respective principal surfaces. It is not seen how such a structure can be derived from Lebeye or Abshagur while still meeting the requirement the optical devices of the two substrates face either other.

In regards to Claim 15, again the art fails to suggest fabricating a plurality of optical devices in two substrates and then bonding the two substrates together. A minor editorial error is corrected in Claim 15. Another new dependent claim recites bonding along the principal surfaces.

The Examiner has rejected Claims 2 and 12 under 35 U.S.C. §103(a) as being obvious over Labeye and Abushagur and further in view of U.S. Patent 5,912,608 to Asada. This rejection is traversed. First, these claims depend from claims believed to be in allowable form and should therefore also be allowable. Secondly, the tiltable MEMS plate of Asada, while resembling the individual ones of the MEMS plates of the present disclosure, is directed to a different application not suggesting an array of such elements. Further, Asada's MEMS plate incompatible with the movable MEMS elements of Labeye or Abushagur.

As to the first point, Asada is describing a galvanometer in which the amount of current passing through drive coils 15A, 15B is measured by monitoring the direction of laser light reflected from the mirror plate that is tilted by the current. There is no suggestion that such a structure be replicated to form a plurality of galvanometer, nor is there a suggestion that the mirror plate be used in an optical switch, as being claimed.

As to the second point, even is Asada's mirror plate were replicated in an array, it would not be usable with the systems of Labeye or Abashagur. The latter two references deflect light within the plane of the substrate. In contrast, Asada deflects light out of the plane of the substrate. Yet further, the deflection of Labeye is an angle depending upon the degree of linear

movement of the optical element and does not significantly depend upon the tilt angle of the mechanical element while the deflection angle of Asada is directly to the tilt angle. The technologies and geometries are too disparate to obviously combine. Accordingly, these claims should be held additionally allowable.

A new set of claims have been added that are clearly distinguished over the applied art.

The Examiner states that Claim 17 would be allowable if rewritten in independent form. It has been so rewritten.

An Information Disclosure Statement is submitted herewith citing U.S. Patent 4,867,421.

In view of the above amendments and remarks, reconsideration and allowance of all claims are respectfully requested. If the Examiner believes that a telephone interview would be helpful, he is invited to contact the undersigned attorney at the listed telephone number, which is on California time.

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Respectfully submitted,

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Version with markings to show changes made

In the specification:

Paragraph at page 3, lines 11-14:

The invention further includes an assembly of a number of such devices, in which the optical elements are installed close together in one or more planes. When the above-mentioned thin-film and etching techniques are used, densities from 100 elements per square centimeter to as much as 10,000 per square centimeter are possible.

Paragraph at page 3, lines 18-28:

A signal or beam deriving from a conductor drops through an optical element and is transmitted/reflected, converged/diverged and/or changes direction, whether or not dependent on the wavelength. In this case the optical parameters of the incident electromagnetic radiation (such as angle of incidence, convergence, divergence, wavelength distribution and intensity) and the geometrical parameters (such as structure, layer thickness distribution, orientation and position) and material parameters (such as refractive indices and transmission coefficient) of the optical element concerned, together determine the optical parameters of the transmitted electromagnetic radiation (such as angle of incidence, convergence, divergence, wavelength distribution and intensity). The optical parameters of the transmitted signal or beam are adjustable by means of the orientation or position of the optical element. Thus a number of signals or beams can be switched in parallel.

Two Paragraphs at page 4, line 28 to page 5, line 11:

MEMS allows the electrical control of the orientation of micromechanical elements, such as those illustrated in FIGS. 1 and 2. Two forms of electrical control elements are piezoelectric and electrostatic elements. A piezoelectric control configuration is illustrated in the cross-

sectional view of FIG. 3. A piezoelectric element 40 including a thin layer 42 of piezoelectric material such as strontium titanate is formed between two electrode layer 44, 46 formed on a substrate 48 constituting the mechanical element. Application of a voltage across the electrode layers 44, 46 causes the piezoelectric layer 42 to deform, thereby affecting the orientation or position of the mechanical element 48 also supporting the optical element used for switching. An electrostatic control configuration is illustrated in the cross-sectional view of FIG. 4. Typically a first electrode 50 is formed on a suspended mechanical element 52 [42] and a second electrode 54 is formed on a base mechanical element 56 with a vertical gap 58 formed between the two electrodes 50, 54. Typically the suspended mechanical element 52 [42] can be rotated, such as in the gimbaled structure of FIG. 2, or be deformed as in a cantilever having an optical element on its free end. Applying an electrical bias across the two electrodes 50, 54 creates an electrostatic attraction between the two mechanical elements [50,] 52, 56, thereby attracting them together assuming some flexibility has been imparted to the suspended mechanical element 52. In the 2-dimensional arrangement of FIG. 2, separate electrodes 54 may be positioned beneath selectively biased electrode portions of the frame 32 and the central plate 34 to allow independently addressable electrostatic control of their angular orientations about two perpendicular axes generally within the plane of the wafer and thus providing independent adjustment of the plural elements. Typically, the two mechanical elements 50, 56 are formed from separate silicon wafers bonded together. The pairs of two opposed electrodes for the plural pixels of a 1- or 2-dimensional arrangement are separately controllable to effect the separate angular control of multiple optical elements. Similarly, plural piezoelectric elements of FIG. 3 may be formed in 1- or 2-dimensional arrangements for separately controllable elements.

Replace the claims with:

1. (Amended) An assembly of a plurality of individually adjustable optical switching devices [device] formed from a substrate having a principal surface and distributed two dimensionally in said principal surface, each of said optical devices comprising:

a deformable mechanical element extending in a direction parallel to said principal surface;

an optical element supported on said mechanical element and providing at least partial transmission therethrough of light incident thereupon into any of plurality of directions extending closer to a normal to said principal surface than parallel to said principal surface; and

an electrical control element controllably deforming said mechanical element and thereby selecting one of said plurality of directions.

Please cancel Claims 6 and 7.

8. (Amended) An assembly, comprising:

a first plurality of [the] optical devices [of Claim 1] formed from a first substrate [one of said substrates] and distributed in a plane of said first substrate; and

a second plurality of [the] optical devices [of Claim 1] formed from a second substrate [one of said substrates] and distributed in a plane of said second substrate;

wherein said first and second substrates are bonded together and allow a beam of light to be transmitted through optical elements on both of said substrates; and

wherein each of said optical devices formed on one of said first and second substrates comprises:

a deformable mechanical element extending in a direction parallel to a principal surface of said one substrate;

an optical element supported on said mechanical element and providing at least partial transmission therethrough of light incident thereupon into any of plurality of directions extending closer to a normal to said principal surface than parallel to said principal surface; and

an electrical control element controllably deforming said mechanical element and thereby selecting one of said plurality of directions.

11. (Amended) The optical switch of Claim 10, wherein said two substrates are bonded together respectively along said principal surfaces thereof with said switching elements of said first substrate face said switching elements of said second substrate.

15. (Amended) A method of manufacturing an optical switch, comprising the steps of:

a first step of fabricating in a first substrate an array of a plurality of optical switching elements;

a second step of fabricating in a second substrate an array of a plurality of optical switching elements; and

bonding together said substrates so that the switching elements of said two substrates face each other;

wherein each of said optical switching elements includes

a deformable mechanical element,

an electrical control element controlling an angular orientation of said mechanical element, and

a [an] transmissive optical element supported on said mechanical element and allowing passage of light between said two arrays of switching elements.

17. (Amended) A [The] method of [Claim 15] manufacturing an optical switch, comprising the steps of:

a first step of fabricating in a first substrate an array of a plurality of optical switching elements;

a second step of fabricating in a second substrate an array of a plurality of optical switching elements; and

bonding together said substrates so that the switching elements of said two substrates face each other;

wherein each of said optical switching elements includes

a deformable mechanical element,

an electrical control element controlling an angular orientation of said mechanical element, and

a transmissive optical element supported on said mechanical element and allowing passage of light between said two arrays of switching elements, wherein said bonding step is performed between said two fabricating steps; and

wherein said bonding step is performed between said two fabricating steps.

Please add the following new claims:

20. (New) The assembly of Claim 1, wherein said deformable mechanical element in respective ones of said optical switching devices tilts about respective axes parallel to said principal surface.

21. (New) The assembly of Claim 1, where said deformable mechanical element in respective ones of said optical switch devices is rotatable out of a plane of said principal surface.

22. (New) The assembly of Claim 1, further comprising a two-dimensional array of optical fibers optically coupled respectively with corresponding ones of said optical elements.

23. (New) An assembly, comprising:

a first plurality of the devices of Claim 1 formed from a first one of said substrates and distributed in a plane of said first substrate; and

a second plurality of the devices of Claim 1 formed from a second one of said substrates and distributed in a plane of said second substrate;

wherein said first and second substrates are bonded together and allow a beam of light to be transmitted through optical elements on both of said substrates.

24. (New) The assembly of Claim 8, wherein said two substrates are bonded together respectively along said principal surfaces thereof.

25. (New) The method of Claim 15, wherein said first and second substrates are bonded together respectively along said principal surfaces thereof.

26. (New) An optical switch, comprising:

a first substrate having formed within a first principal surface thereof a first array of at least partially transmissive first optical elements which are individually tiltable about respective first axes extending parallel to said first principal surface; and

a second substrate having formed within a second principal surface thereof a second array of at least partially transmissive second optical elements which are individually tiltable about respective second axes extending parallel to said second principal surface;

wherein optical paths are selectively formed between said first and second optical elements by tilting selected ones of said first and second optical elements.

27. (New) The optical switch of Claim 26, wherein said first and second substrates are juxtaposed with said first and second principal surfaces facing each other.

28. (New) The optical switch of Claim 26, wherein said first and second substrates are bonded together along said first and second principal surfaces.

29. (New) The optical switch of Claim 26, further comprising control elements respectively associated with individual ones of said first and second optical elements to effect tilting thereof.

30. (New) The optical switch of Claim 26, wherein said first and second arrays are both two-dimensional arrays.